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Title: Multiple feeding strategies observed in the cold-water coral *Lophelia pertusa*

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Abstract

Cold-water coral reefs are biodiversity hotspots of the deep sea. The most dominant reef building cold-water coral in the Atlantic is *Lophelia pertusa* which builds vast and structurally complex habitats. Studying the behaviours of deep-sea species is challenging due to the technological difficulties in making prolonged observations *in situ* so little is known about the behavioural ecology of this important species. Observations in laboratory studies can help to enhance our understandings of the range of behaviours these species have. Here we present video evidence that the cold-water coral *Lophelia pertusa* is capable of producing mucus nets as part of their feeding strategy. This finding suggests that have a more diverse range of feeding strategies than previously thought.

Introduction

Cold-water coral reefs are biodiversity hotspots of the deep sea. In contrast to their shallow, tropical counterparts, these reefs are dominated by only a handful of reef framework-forming scleractinian corals, yet these few species build vast and structurally complex reefs that support up to an estimated 1,300 species (Roberts et al. 2009). Since the discovery of the ecological importance of these diverse, deep-sea communities, and the rapid technological advancement for exploring the deep sea at the end of the last century, interest in cold-water corals has grown rapidly. For the North Atlantic, *Lophelia pertusa* is the best studied, arguably most significant, and most widespread reef building cold-water coral (e.g. Rogers 1999, Freiwald & Roberts 2005). Despite this attention, observations of the behavioural ecology of *L. pertusa* remain limited due to the inaccessibility of their remote, deep-sea homes. However, in contrast to many deep-sea species, *L. pertusa* has an extensive depth range (39 m - 3380 m, Mortensen et al. 2001) and is able to survive collection and transport to marine laboratories where they can be maintained for months to years (e.g. Hennige et al. 2015). This allows an insight into their behaviours that is beyond the scope of our current capabilities *in situ*. Here we report on feeding behaviours recorded in laboratory mesocosms that suggest that the feeding strategies of *L. pertusa* are more diverse than previously thought.

It has been established that the diet of *L. pertusa* consists predominantly of zooplankton and phytodetritus (Carlier et al. 2009, Mueller et al. 2014), and previous laboratory observations reported that polyps caught food items through nematocyst adhesion (Mortensen, 2001): that is, they capture items that come into contact with their tentacles. Polyps then transfer particles to the centre of the oral disc and into the pharynx for consumption. Mortensen (2001) noted that small amounts of mucus were also excreted when potential prey had come into contact with the tentacles but had subsequently escaped. Our understanding of the production of mucus in relation to feeding was previously limited to Mortensen's observations and it was thought that *L. pertusa* was limited to consuming food items that came into direct contact with its tentacles. Indeed, mucus excretion has been predominantly reported as a disturbance response (Mortensen 2001), an antifouling strategy (Reitner 2005) and to have a role in skeletal growth (Reitner 2005). However, we have now produced video evidence on a freshly collected *L. pertusa* specimen that *L. pertusa* is able to construct mucus nets that it casts into the water column to capture food.

Methods

Colonies of *Lophelia pertusa* were collected using a modified video assisted van-Veen grab[3] from 141 – 167 m depth at the Mingulay Reef Complex, Outer Hebrides, UK (56°49'N, 7°23'W, see Fig. 1 in Hennige et al. 2014), in June 2011 during the RRS *Discovery* D366/7 Cruise. Upon return to the surface, corals were placed in a holding tank at ambient seabed temperature conditions (9.5 °C) for 2 days, to recover from collection, at which time polyps were extended and feeding and mucus was no longer visibly being produced (Hennige et al. 2014). Corals were then carefully fragmented into smaller pieces (Hennige et al. 2014). These fragments had 5-20 polyps, and were taken from the top of sampled colonies to ensure that relatively young polyps were used consistently, as polyp age can determine physiological response (Maier et al. 2009). Coral fragments were transferred to tanks in a 10 °C temperature-controlled room, fed cultured *Artemia salina*, and acclimatised for five days, (comparable to Naumann et al. 2014).

The fragment presented here was filmed for 1 hour using a Canon PowerShot G9. The video was edited using Final Cut Pro X (version 10.3) and sped up 5 times.

Results and Discussion

Following the introduction of *A. salina*, small quantities of mucus were released creating two distinct and separate mucus nets. Subsequently the nets and captured *A. salina* were consumed (Fig. 1). The entire process from net production to consumption lasted approximately 18 minutes, far longer than an ROV (remotely operated vehicle) generally spends on a single patch of coral during deep-sea expeditions, making it difficult to observe such behaviours *in situ*. The key sequence is presented in still images (Fig. 1) and video clips are included as a digital supplement (Video S1). Whilst corals habitually produce mucus as a stress response when collected, our acclimation procedures and observations that the mucus nets were only produced in the presence of food allows us to conclude that this is a feeding behaviour.

These observations suggest that *L. pertusa* has a more diverse range of feeding strategies than previously thought. The prevalence and frequency of the use of mucus nets remains unknown, however other benthic species use a similar strategy and have been more comprehensively studied. Polychaetes (e.g. *Hediste diversicolor*, Riisgård 1991) and gastropods (e.g. *Dendropoma maximum*, Rybak et al. 2005) for example, produce mucus nets as part of their suspension feeding strategies. In both cases, environmental cues, such as food availability, have been shown to influence choice of feeding method.

Scleractinian coral mucus is functionally important and a prominent source of dissolved organic matter (DOM) in both warm and cold-water coral reefs (Rix et al. 2016). It plays a key role in nutrient cycling (Wild et al. 2008) and drives the “sponge loop”- the key trophic pathway to transfer DOM, the most abundant nutrient rich resource on tropical coral reefs, to higher trophic levels (de Goeij et al. 2013).

Our observations suggest that the functions of mucus for the coral itself may also be more diverse and important than first appears.

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Figure legend

Fig. 1: Production and consumption of mucus net: (a) free swimming *A. salina*, (b) production of mucus net and trapping of plankton, (c-d) pulling in of mucus net towards oral disc, (g) absence of mucus net after consumption. The black dots approximately represent visible *A. salina*.

Appendix

Video S1: *L. pertusa* catching and consuming *A. salina* using a mucus net.